UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Plant Industry

INVESTIGATIONS ON THE PRECOOLING AND TRANSPORTATION OF FLORIDA CITRUS FRUIT - 1940-41

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In compliance with a memorandum of understanding between the Florida Citrus Commission and the U. S. Department of Agriculture, citrus transportation studies were begun during the season of 1938-39 to develop information that would be useful to shippers in making satisfactory delivery of fruit to northern markets and insure its remaining in good condition until it reaches the consumer. This, the third annual progress report under the cooperative project, gives the salient facts developed during the shipping season of 1940-41. It attempts to correlate precooling temperatures, temperatures during transit, and other factors with the condition of the fruit after arrival at destination.

Seventy-eight tests were conducted during the season, seven of which were by boat and seventy-one, by rail, the greatest number of tests ever made by the Department during one season on a single commodity.

All of the test shipments by boat and 55 of those by rail were "shipping" tests; that is, temperatures between packing house and destination were recorded only by means of thermographs placed in the center of test boxes of oranges, but these tests were not accompanied to destination by observers. The remaining 16 were "transportation" tests, made after the middle of May, and were accompanied by observers who took fruit temperatures with electric resistance thermometers several times daily en route to market without opening the cars.

The test cars were usually unloaded on the day of arrival at destination, but on several occasions there was a delay of one or more days. The test boxes from each car were taken to the U. S. Department of Agriculture laboratory and immediately inspected for general appearance, rind breakdown, and decay; then the fruit was repacked and held for one week at temperatures which ranged during the season from [illegible]° to 72°. At the end of this time a final inspection was made to determine what changes occur while the fruit is going into consumption after arrival at the market.

It was planned that each comparison be repeated several times, but market conditions or a rather limited supply of test equipment made repetitions of all comparisons impossible.

This is a summary of the results of the tests conducted during the season of 1940-41. Copies of a detailed report on the investigation are on file with the Florida Citrus Commission, Lakeland, Fla., as well as at the offices of the Bureau of Plant Industry in Orlando, Fla. and Washington, D. C., where they may be consulted by interested parties. Formal publication of results is not contemplated until the investigation is completed, which will necessarily require several more seasons' work.

Florida citrus fruits are attacked by the two major stem-end rot fungi, Diplodia and Phomopsis, as well as by Penicillium. Diplodia is much more active and usually more prevalent than Phomopsis, especially in warm weather, and causes most of the stem-end rot in gassed fruit. For reasons not known, Diplodia appeared to only a slight extent this season. The gassing treatment which ordinarily stimulates Diplodia rot, failed to do so this year. On the other hand, Phomopsis rot, which

is caused by the melanose fungus and is slow to start, was prevalent. This probably explains why decay on arrival in both commercial and test shipments was much less common than in former years.

Decay developed so slowly in the lots of fruit used in the shipping tests that ~~the~~ clear-cut differences in keeping quality attributable to transit temperatures did not appear even during the one-week holding period. The transit period of three or four days to New York or Chicago is so short that decay or other spoilage does not ordinarily develop seriously, by the time of arrival even in non-precooled shipments. Although these tests failed to show any marked effect of transit temperatures on decay, they did show such effects on rind conditions, especially <u>withering and aging</u>.

Room precooling gave more satisfactory temperatures than other precooling services available to shippers, if the fruit was left in rooms for about twenty-four hours. Fruit can be effectively precooled in cars as well as in rooms if sufficient time is taken.

No great difference was apparent in the efficiency of the several methods of car precooling. About 15° or 20° reduction in temperature was a fair average in the first four or five hours.

After the termination of precooling, there was sometimes a marked change in commodity temperature. The greatest change, averaging about 10° rise in the top of the load during the first twelve hours, was found when room-precooled fruit was loaded into warm cars. The car precooled fruit did not change so much because the car was cooled along with the load. The top commodity temperatures in cars with ice in the bunkers rose about 5° or 6° in the first twelve hours, while those in the bottom of the load fell almost 10°. The top commodity temperatures in the cars precooled with mechanical refrigeration rose only about 4°

or 5° during the same time, while those in the bottom fell a degree or two.

Calculations based on ice meltage during precooling of standard loads with fans, ice, and salt showed an average drop of 3.4° for each 1,000 pounds of ice melted.

After arrival at destination the condition of the usual "cold-hold"-boat shipments compared favorably with that of room-precooled rail shipments, vents closed to destination, and both were quite superior to non-precooled fruit initially iced and ventilated in transit.

Between March and May tests were made as follows: (1) non-precooled fruit under standard ventilation; (2) room-precooled fruit loaded in cars with bunkers dry, vents closed to destination; (3) fruit precooled in cars with fans, ice, and salt, vents closed to destination (shipments to New York reiced under Item 295); and (4) fruit precooled in cars with mechanical units, cars to New York iced under Item 295 after pre-cooling, vents closed to destination, cars to Chicago not iced, vented at Atlanta. At time of unloading as well as after the one week holding period the greatest amount of withering, aging, and loss in weight was found in fruit from cars under standard ventilation and in that from mechanically precooled cars with dry bunkers vented in transit; the least withering, aging, and loss in weight was found in room-precooled fruit shipped in cars with bunkers dry, vents closed to destination.

Fruit in initially iced cars, changed to standard ventilation en route, and vented during the drier part of the day, deteriorated more than that in cars ventilated during the more humid hours.

Broquinda cars with precooled fruit were again tested. Because of the position of their cooling coils on the upper sidewalls of the car, a more uniform commodity temperature was maintained in them during transit than in water iced conventional end bunker cars. However, the results indicated that the Broquinda cars had no practical advantage over conventional cars in transporting citrus fruit.

Under weather conditions necessitating icing of precooled fruit, the advantages of upper half bunker icing were again demonstrated. Ice in the upper part of the bunker proved more effective in cooling the top of the load, where refrigeration is most needed, than a greater amount of ice in the lower part of the bunker, and was correspondingly cheaper.

Tests were made of cars equipped with fans under the floor racks, which can be operated for precooling and to increase air circulation while the car is in motion. For precooling, the fans in these cars were as satisfactory as the more common bunker fans. While these fan cars were in motion, the fans were operated from the car wheels and forced cold air up through the bunkers and over the load, thereby reducing the spread in temperature between the top and bottom. After the car was well on its journey, the top commodity temperatures were about as low as, and sometimes lower than, those in the bottom of the load. When the car was standing still, the bottom fruit became cooler, while that in the top warmed up somewhat. However, the transit period was too short to secure any marked benefit in the condition of the fruit from these temperature differences.

In June a heavy-load test of precooled fruit was made consisting of three cars of oranges in wire-bound boxes loaded six high on their sides. Two of these were in fan cars and one was in a conventional car.

The loads arrived in good condition, and no ill effects were observed that could be attributed to the extra weight. The condition of the fruit in these heavy loads compared favorably with that in normal loads in the same test.

A comparison was made of a normal load of precooled oranges in standard boxes with a similar load of oranges in wire-bound boxes. The top commodity temperatures were closely parallel during transit. The fruit in both cars arrived in good condition and little difference in the keeping quality was noted.

Borax applied before the fruit was given the ethylene treatment reduced decay in both precooled and non-precooled lots, and was more effective than precooling. The double treatment, borax and precooling, gave the best control. Withering and aging were more prevalent in the borax-treated lots than in the checks, but the importance of this was more than offset by the smaller amount of decay in the borax-treated fruit. In the investigations during the past season the fast growing stem-end rot fungus Diplodia was rarely encountered, but had it been as abundant as in former years, it is probable that the difference in decay between the treated and untreated lots would have been greater.

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